Frontal Dynamics in the South China Sea: High-Resolution Hydrographic Surveys at the Shelfbreak (ASIAEX)

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LONG-TERM GOALS

The long-term goal is to understand thermohaline and velocity structure near a low-latitude shelfbreak, and their effect on sound propagation between the continental shelf and slope.

OBJECTIVES

The primary objective is to examine the cross-shelf and along-shelf gradients of the thermohaline and velocity fields to determine whether or not there are frontal structures near the shelfbreak in the South China Sea. We also wish to determine which processes contribute to variability of the thermohaline and sound speed fields near the shelfbreak.

APPROACH

In close collaboration with Taiwanese colleagues at National Taiwan University (NTU), we completed two SeaSoar surveys in the ASIAEX study region in the South China Sea, a pilot study using the Taiwanese SeaSoar in April 2000 and the main field study using the WHOI SeaSoar in shallow water in April–May 2001. In both years, a large-scale survey was also conducted in the northern portion of the South China Sea so that larger scale circulation patterns could be determined. The 2001 SeaSoar cruise was conducted concurrently with the deployment of a large moored array that featured Acoustic Doppler Current Profilers, temperature chains, and other physical oceanographic instrumentation in

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addition to acoustic sources and receivers. Combined analysis of the SeaSoar data, the moored array physical data, and remote sensing data collected by other ASIAEX investigators should allow us to develop a detailed description and understanding of the water structure and current variability in the study area on time scales from minutes to days and length scales from meters to the mesoscale.

WORK COMPLETED

The NTU SeaSoar was used for both the deep and shallow surveys in 2000. The WHOI SeaSoar (Figure 1) was used for the shallow water survey in 2001. The WHOI SeaSoar was configured to measure temperature, salinity, fluorescence, light transmittance, and bioluminescence. The vehicle typically made one complete vertical (down/up) profile every 0.4 km in 100-m water depth near the shelfbreak. The 2001 cruise featured repeat across-shelf sections (Figure 2); a total of seven SeaSoar grids were sampled during April 29–May 10, 2001 in addition to the large-scale survey by NTU.

The shipboard ADCP data from both 2000 and 2001 cruises have now been processed. Processing of the SeaSoar 2001 data has been completed, but we are currently examining different averaging techniques to resolve some of the smaller scale features present in the data set.

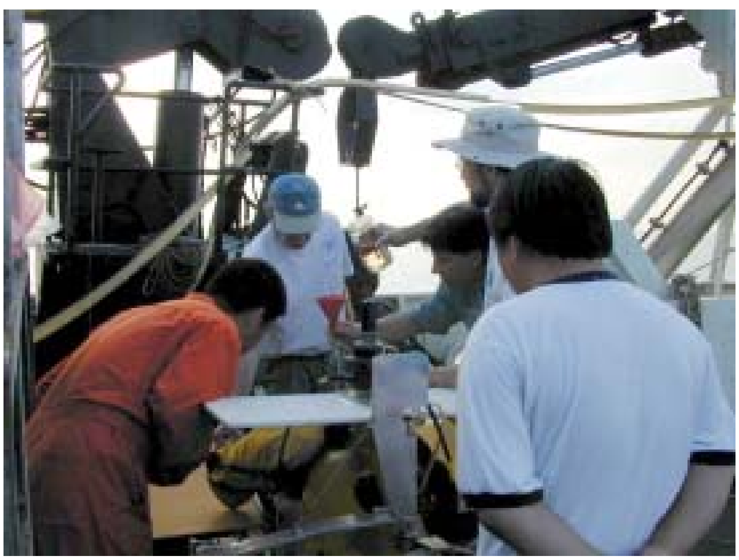

Figure 1. WHOI SeaSoar on deck

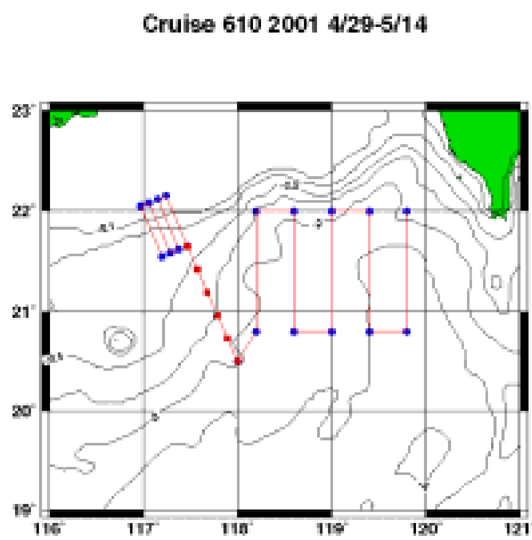

Figure 2. SeaSoar survey pattern for 2001 cruise.

RESULTS

Preliminary analysis of the data shows very large differences in the nature of the offshore forcing between the two field years. During April 2000, there was a strong onshore flow of Kuroshio intrusion water, resulting in very large vertical and horizontal velocity shears near the shelfbreak. However, in 2001, there was not a significant onshore flow, and the flow field appears to have been dominated by tidal and high frequency motion.

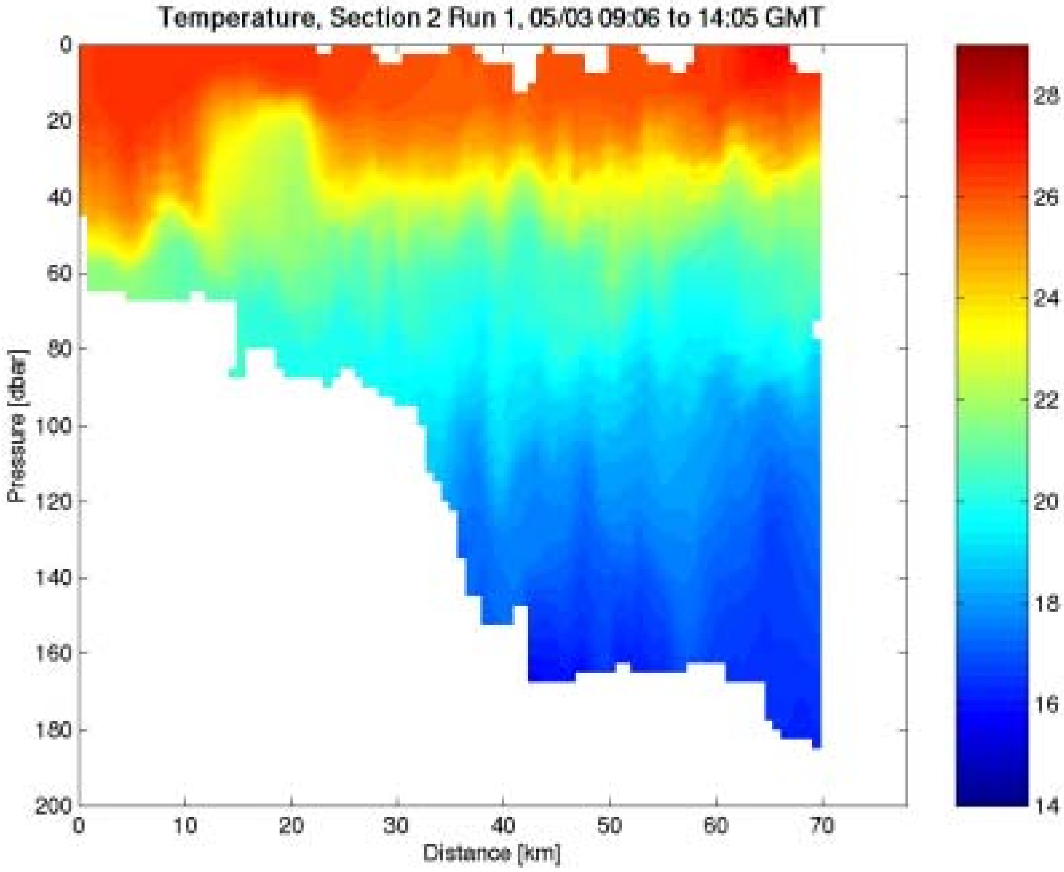

Figure 3. A cross-shelf section of temperature from May 3, 2001, showing a large-amplitude depression of the isotherms near the steep topography (x = 40 km). Also note the elevated isotherms near x = 15 km.

A particularly interesting aspect of this data set is the interaction of remotely forced, nonlinear internal waves (internal solitary waves or "solitons") with the steep topography in this region (Figure 3). There was considerable variability of near-bottom temperatures shoreward of the steep topography as these large-amplitude internal waves propagated into shallow water. This temperature variability is associated with large cross-shelf velocities (Figure 4).

In contrast to spring of 2001, the flow field in April 2000 contained very strong lateral shears in the upper 50 m of the water column, with relative vorticities comparable to the local Coriolis parameter This was due to a strong onshore flow of 0.6 m/s associated with an intrusion of Kuroshio water. There was also a cool, near-bottom layer of shelf water, which appears to have been carried offshore in some filamentary structures. This work was presented at the 2000 Fall AGU Meeting.

IMPACT / APPLICATIONS

This data set is important in understanding the dynamics of low-latitude shelfbreak regions, where the ambient stratification is very strong and the relative importance of the Coriolis acceleration may be reduced. The contrast between the two field years should offer important insights into the possible pro-

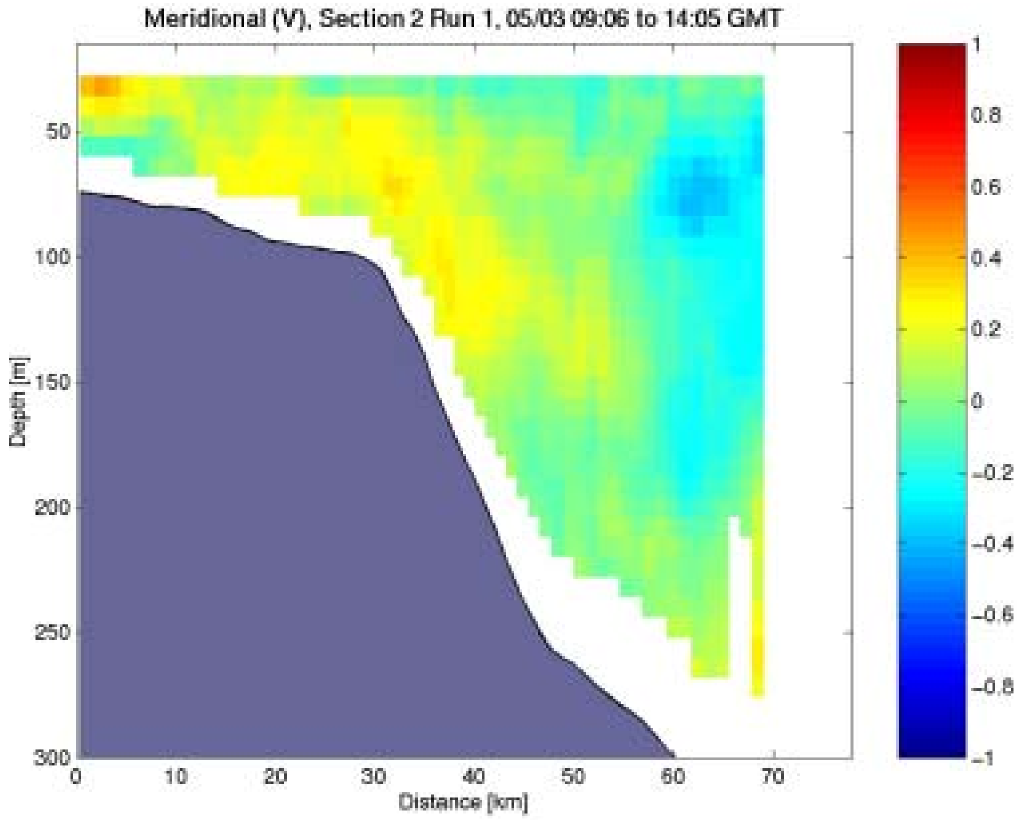

Figure 4. Northward (shoreward) velocities show strong cross-shelf flow, with strong near-bottom velocities onshore of the shelfbreak.

cesses affecting inter-annual variability. Because of the profusion of concurrent moored data, we should be able to learn a great deal about how shelfbreak flows affect the ambient high-frequency motions including internal solitary waves. We will also be working closely with the ASIAEX acousticians to see how the mesoscale and high-frequency flows affect acoustic propagation. A particularly interesting issue at this early stage is the extent of cool near-bottom layers over the shelf, leading to downward refraction of sound and potentially enhanced bottom attenuation. Results from this program will also be applied to the quantification of uncertainty for sonar systems in shelfbreak environments, which in general contain a high-degree of variability. We are also interacting with R. Preller and D. Ko of the Stennis Space Center, Naval Research Laboratory, to understand how operational models produce the Kuroshio intrusion into the South China Sea.

TRANSITIONS

None.

RELATED PROJECTS

Results from this work will be used for the DRI "Capturing Uncertainty in the Tactical Environment" as well as the DRI "Effects of Sound in the Marine Environment."

REFERENCES

None.

PUBLICATIONS

Gawarkiewicz, G., J. Wang, F. Bahr, and R. Beardsley. A sub-surface front near the shelfbreak in the South China Sea: Results from the ASIAEX field program. *EOS, Transactions, American Geophysical Union*, 81(48), p. F748 (abstract).